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An assessment of full-wave effects on the propagation and absorption of lower hybrid waves[1]

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Lower hybrid (LH) waves have the attractive property of damping strongly via electron Landau resonance on relatively fast tail electrons. Consequently these waves are well-suited to driving current in the plasma periphery where the electron temperature is lower, making LH current drive (LHCD) a promising technique for off–axis (r/a∼0.60) current profile control in reactor grade plasmas. Established modeling techniques use WKB expansions with non-Maxwellian self-consistent distributions. Higher order WKB expansions have shown some effects on the parallel wavenumber evolution and consequently on the damping due to diffraction [1]. A massively parallel version of the TORIC full-wave electromagnetic field solver valid in the LH range of frequencies has been developed [2] and applied to scenarios at the density and magnetic field characteristic of devices such as Alcator C-Mod and ITER [B0≈5 T, ne≈ 1×10^{20} m^{-3}]. We find that retaining full wave effects due to diffraction and focusing has a strong effect on the location of wave absorption. Diffraction occurs at caustic surfaces and in resonance cones resulting in a large upshift of the parallel wavenumber and localized power deposition. For some values of density and magnetic field when the waves are fully accessible to the center of the plasma, the full wave description predicts all power being damped at larger radii (r/a ∼ 0.7) in contrast to ray tracing which shows more central power absorption. By incorporating a Fokker-Planck code for self-consistent treatment of the electron distribution and using an synthetic hard X-ray diagnostic we compare the code predictions by both full wave and ray tracing methods with recent Alcator C-Mod experiments. We will compare full-wave and ray tracing for low and high single pass damping regimes.

[1] G. Pereverzev, Nucl. Fusion 32 1091 (1991).
[2] J. C. Wright, E. J. Valeo, C. K. Phillips and P. T. Bonoli, Comm. in Comput. Physics 4 545 (2008).

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